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THESIS

**U.S. NAVAL OFFICER ACCESSION SOURCES:
PROMOTION PROBABILITY AND
EVALUATION OF COST**

by

Matthew D. Sharra

June 2015

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This thesis explores the promotion probability to lieutenant commander (O-4) and commander (O-5) of major naval officer accession sources. This is important because there have been few studies to analyze the possible correlation of promotion relating to accession source and cost effectiveness.

I used multivariate regression to examine the possibility of promotion of naval officers from the United States Naval Academy (USNA), Naval Reserve Officer Training Corps, and Officer Candidate School (OCS) who commissioned between fiscal years 1990 and 2000.

My results showed OCS officers, on average, had a higher probability of promotion to O-4 and USNA officers, on average, had a higher probability of promotion to O-5. My regression also showed officers with graduate degrees, on average, had an increased probability of promotion in comparison to those who did not. OCS officer accessions had lower marginal costs due to shortened training timelines and post-commissioning training costs were similar for all three sources.

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U.S. NAVAL OFFICER ACCESSION SOURCES: PROMOTION PROBABILITY AND EVALUATION OF COST

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I used multivariate regression to examine the possibility of promotion of naval officers from the United States Naval Academy (USNA), Naval Reserve Officer Training Corps, and Officer Candidate School (OCS) who commissioned between fiscal years 1990 and 2000.

My results showed OCS officers, on average, had a higher probability of promotion to O-4 and USNA officers, on average, had a higher probability of promotion to O-5. My regression also showed officers with graduate degrees, on average, had an increased probability of promotion in comparison to those who did not. OCS officer accessions had lower marginal costs due to shortened training timelines and post-commissioning training costs were similar for all three sources.

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LIST OF ACRONYMS AND ABBREVIATIONS

CPI	Consumer Price Index
DMDC	Defense Manpower Data Center
ECP	Enlisted Commissioning Program
ENS	ensign
FY	fiscal year
GAO	Government Accountability Office
GFY	gain fiscal year
LCDR	lieutenant commander
LTJG	lieutenant junior grade
LT	lieutenant
MECP	Medical Enlisted Commissioning Program
OCS	Officer Candidate School
NC	Nurse Corps
NCO	Nurse Corps officer
NCP	Nurse Commissioning Program
NPS	Naval Postgraduate School
NROTC	Navy Reserve Officer Training Corps
NROTC-C	Navy Reserve Officer Training Corps contract
NROTC-S	Navy Reserve Officer Training Corps scholarship
RL	restricted line officer
STA-21	Seaman to Admiral Program
URL	unrestricted line officer
USNA	United States Naval Academy
YCS	years of commissioned service

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I.   INTRODUCTION

The United States Navy commissions thousands of naval officers each year, spending millions of dollars in training and education on these future officers in order to meet annual requirements. The Navy uses three major commissioning sources to produce future naval officers: United States Naval Academy (USNA), Naval Reserve Officer Training Corps (NROTC), and Officer Candidate School (OCS). Few studies have undertaken the comprehensive analysis required to determine if one source is more cost-effective than the others. The Department of Defense (DOD), specifically the Office of the Secretary of Defense (OSD), needs a framework for allocating funds toward these commissioning sources. In an era of budget and fiscal constraints, top decision makers need to be able to efficiently allocate dollars. There are potential savings in a steady state environment by marginally increasing USNA accessions compared to OCS accessions (Parcel, 2001). If one commissioning source has potential cost savings in one area, is there a proper trade-off for cost savings in another? This research provides OSD with dependable scientific information about the Navy's officer commissioning programs' cost-effectiveness.

A.   PURPOSE

My thesis provides a systematic analysis of naval officer accessions sources during fiscal years (FY) 1990 through 2000. These accession sources include USNA, NROTC, and OCS. My research uses multivariate analysis to determine the cost-effectiveness of these accession sources, comparing retention and promotion success to O-4 and O-5 paygrades. Previous accession source studies only used USNA, NROTC, and OCS programs in their analyses (Bowman, 1995; Parcel, 2001).

(1)   Primary Research Questions

- What is the most cost-effective commissioning source to provide officers for promotion to O-4 and O-5?
- Since there are different commissioning sources, do any have historical trends for long-term retention and promotion? This analysis looks mainly at cost effectiveness between these sources.

(2) **Secondary Research Questions**

- What is the estimated cost savings to be realized by utilizing one commissioning source over another?
- Specifically, what is the cost-benefit for the Navy to best allocate dollars into these sources?

B. ORGANIZATION OF STUDY

Chapter II reviews prior research that has been conducted on naval officer accession programs. Chapter III presents the data used in this thesis and the research methodology, and Chapters IV and V provide the analysis and multivariate regression results. Chapter VI provides the cost analysis and Chapter VII completes with a summary, a conclusion, recommendations, and topics for future research.

II. LITERATURE REVIEW

This chapter reviews prior research conducted on officer source accessions. This thesis largely builds upon the work done previously by Joel Bernard (2002), who analyzed alternate accession sources, and William Bowman (1995), who analyzed cost-effectiveness of service academies.

A. ANALYSIS OF ALTERNATE ACCESSION SOURCES

The 2002 NPS thesis by Joel Bernard, titled *An Analysis of Alternate Accession Sources for Naval Officers*, analyzed the joint probability of retention and promotion outcomes of naval officers to the O-4 promotion level and the cost-effectiveness of each commissioning source (Bernard, 2002). Bernard's thesis used multivariate logit models of retention and promotion to specify the independent effect of an accession source on unrestricted line (URL) and restricted line (RL) officer retention and promotion outcomes (Bernard, 2002). Bernard's study provides the methodology that is applied in this thesis. The accession sources analyzed were USNA, NROTC, OCS, and ECP. NROTC was separated into NROTC Scholarship (S) and NROTC Contract (C). The Enlisted Commissioning Program (ECP) was combined with other enlisted-to-officer commissioning programs to form Seaman to Admiral 21 (STA-21) in 1994 (NTSC PAO, 2010).

Bernard used naval officer data card information collected by William Bowman (1995) from FY 1983–1990. The variable data was separated into the following categories: Outcomes, Demographics, Human Capital, College Selectivity, Community Designators, and Control Variables (Bernard, 2002). Table 1 lists the variable data used and its descriptions.

VARIABLE	DESCRIPTION
Outcomes	
STAY04BD	= 1 IF SURVIVED TO O-4 BOARD; = 0 OTHERWISE
HPROM04	= 1 IF PROMOTED TO O-4 AT FIRST LOOK; = 0 OTHERWISE
Demographics	
AGE_COMM	AGE AT COMMISSIONING (IN YEARS)
WHITE	= 1 IF RACE IS WHITE; = 0 OTHERWISE
BLACK	= 1 IF RACE IS BLACK; = 0 OTHERWISE
OTHER	= 1 IF RACE IS NOT WHITE OR BLACK; = 0 OTHERWISE
FEMALE	= 1 IF GENDER IS FEMALE; = 0 IF MALE
SNC	= 1 IF SINGLE WITH NO CHILDREN; = 0 OTHERWISE
SWC	= 1 IF SINGLE WITH CHILDREN; = 0 OTHERWISE
MNC	= 1 IF MARRIED WITH NO CHILDREN; = 0 OTHERWISE
MWC	= 1 IF MARRIED WITH CHILDREN; = 0 OTHERWISE
Human Capital	
SOMEPRIOR	= 1 IF 1 TO 4 YRS ACTIVE ENLISTED TIME; = 0 OTHERWISE
TECHMAJ	= 1 IF UNDERGRADUATE MAJOR IS TECHNICAL; = 0 OTHERWISE
USNA	= 1 IF ACCESSION SOURCE IS USNA; = 0 OTHERWISE
ROTCS	= 1 IF ACCESSION SOURCE IS ROTC SCHOLARSHIP; = 0 OTHERWISE
ROTCC	= 1 IF ACCESSION SOURCE IS ROTC CONTRACT; = 0 OTHERWISE
OCS	= 1 IF ACCESSION SOURCE IS OCS; = 0 OTHERWISE
ECP	= 1 IF ACCESSED UNDER ECP WITH ROTC SCHOLARSHIP; = 0 OTHERWISE
NAPC1	ORDINAL (0-5). ACADEMIC PROFILE CODE (UNDERGRADUATE GPA)
NAPC2	ORDINAL (0-6). ACADEMIC PROFILE CODE (CALCULUS EXPERIENCE)
NAPC3	ORDINAL (0-6). ACADEMIC PROFILE CODE (ENG/PHYSICS EXPERIENCE)
College Selectivity	
TOPCOLL	= 1 IF COLLEGE ATTENDED IS HIGHLY SELECTIVE; = 0 OTHERWISE
MIDCOLL	= 1 IF COLLEGE ATTENDED IS SELECTIVE; = 0 OTHERWISE
LOCOLL	= 1 IF COLLEGE ATTENDED IS NOT SELECTIVE; = 0 OTHERWISE
Community Designators	
SWO	= 1 IF SURFACE WARFARE OFFICER; = 0 OTHERWISE
SUB	= 1 IF SUBMARINE OFFICER; = 0 OTHERWISE
AIR	= 1 IF PILOT OR NFO; = 0 OTHERWISE
SPECWO	= 1 IF SPEC WARFARE OR SPEC OPS OFFICER; = 0 OTHERWISE
SUPPLY	= 1 IF SUPPLY CORPS OFFICER; = 0 OTHERWISE
FLTSUPP	= 1 IF FLEET SUPPORT OFFICER; = 0 OTHERWISE
RLSO	= 1 IF RESTRICTED LINE, NOT SUPPLY OR FLT SUPPORT; = 0 OTHERWISE
Control Variables	
YRG83	= 1 IF ACCESSED IN YEAR GROUP 1983; = 0 OTHERWISE
YRG84	= 1 IF ACCESSED IN YEAR GROUP 1984; = 0 OTHERWISE
YRG85	= 1 IF ACCESSED IN YEAR GROUP 1985; = 0 OTHERWISE
YRG86	= 1 IF ACCESSED IN YEAR GROUP 1986; = 0 OTHERWISE
YRG87	= 1 IF ACCESSED IN YEAR GROUP 1987; = 0 OTHERWISE
YRG88	= 1 IF ACCESSED IN YEAR GROUP 1988; = 0 OTHERWISE
YRG89	= 1 IF ACCESSED IN YEAR GROUP 1989; = 0 OTHERWISE
YRG90	= 1 IF ACCESSED IN YEAR GROUP 1990; = 0 OTHERWISE

Table 1.   Variable Name and Description, Grouped by Category (from Bernard, 2002)

Bernard used a multivariate model with logistical regression to determine the effectiveness of probability of promotion to O-4 of alternate accession sources compared to USNA. This model is shown in Table 2. His model shows that URL officers who access from NROTC programs with scholarships and officers from OCS are less likely to stay until the O-4 promotion board USNA officer accessions (Bernard, 2002).

PROBABILITY OF STAYING TO O-4 FOR URL OFFICERS (YR GROUPS 1983-1990)				
VARIABLE	**PARAMETER ESTIMATE**	**STD ERROR**	**PARTIAL EFFECT (% PT CHANGE)**	**% CHANGE FROM BASE**
Accession Source (compared to USNA)				
ROTC Scholarship	-.1764**	.0411	-.043	-9.2%
ROTC Contract	.0577	.0906	.014	3.0%
OCS	-.3193**	.0426	-.078	-16.7%
ECP	-.3411	.2182	-.083	-17.8%
Technical Major	-.0721**	.0334	-.018	-3.9%
NAPC1 (GPA)	.1237**	.0168	.031	6.7%
Prior Service	.2763**	.1094	.105	22.5%
Black	.0315	.0867	.008	1.7%
Other	-.3814**	.0871	-.093	-20.0%
Female	-.1929*	.1196	-.048	-10.3%
SWC	.6511**	.2693	.160	34.3%
MNC	.2788**	.1279	.070	15.0%
MWC	.2761**	.0324	.069	14.8%
N	17,134			
Base Predicted Probability	.466			
Intercept	-.3872			
-2LogL	22,644.9			
Chi-Sq	331.2			

Asterisks denote levels of statistical significance.
 * = significant at the 90% level; ** = significant at the 95% level.

Table 2.   Basic Retention Model for URL Officers (from Bernard, 2002)

Bernard's 2002 thesis also analyzed the probability of promotion to O-4 of URL officers, if they stayed until the O-4 promotion board. This model was the basic retention model for URL officers, as shown in Table 3. Results of this model indicated that NROTC-S accessions were 8.1 percent less likely to promote and OCS accessions were 1.1 percent less likely to promote than their USNA counterparts.

VARIABLE	PARAMETER ESTIMATE	STD ERROR	PARTIAL EFFECT (% PT CHANGE)	%CHANGE FROM BASE
PROBABILITY OF PROMOTING TO O-4 URL OFFICERS (YR GROUPS 1983-1990)				
Accession Source (compared to USNA)				
ROTC Scholarship	-.2924**	.0683	-.060	-8.1%
ROTC Contract	-.1670	.1399	-.033	-4.4%
OCS	-.0414	.0727	-.008	-1.1%
ECP	.6293	.3998	.102	13.7%
Technical Major	.1239**	.0560	.023	3.1%
NAPC1 (GPA)	-.1290**	.0288	-.025	-3.4%
Prior Service	-.1331	.1470	-.026	-3.5%
Black	-.0370	.1385	-.007	-0.9%
Other	-.2632*	.1484	-.054	7.3%
Female	.1610	.2134	.030	4.0%
SWC	-.4929	.3758	-.105	-14.2%
MNC	.3003	.2171	.053	7.1%
MWC	.1167**	.0560	.022	3.0%
N	6,750			
Base Predicted Probability	.742			
Intercept	1.329			
-2LogL	8,263.9			
Chi-Sq	99.5			

Asterisks denote levels of statistical significance.
* = significant at the 90% level; ** = significant at the 95% level.

Table 3.   Basic Promotion Model for URL Officers (from Bernard, 2002)

Bernard also examined the cost analysis of accession sources in promotion to the O-4 promotion point based on a steady state flow of accessions as determined by William Bowman (1995). Average costs and marginal costs were analyzed using pre- and post-commissioning costs and a steady state flow separated into warfare community and commissioning source. Tables 4 and 5 reflect the average and marginal costs required to maintain a steady state flow.

Accession Source	Discounted Costs			Number of Accessions	Costs Per O-4
	Pre-Commissioning	Post-Commissioning	Total		
SURFACE:					
USNA	229,227	80,044	309,271	4.47	1,382,442
ROTC Scholarship	93,653	70,640	164,293	7.20	1,182,911
ROTC Contract	53,620	82,841	136,461	4.29	585,416
OCS	43,880	79,302	123,182	6.36	783,435
SUBMARINE:					
USNA	229,227	131,656	360,883	4.10	1,479,621
ROTC Scholarship	93,653	129,731	223,384	5.10	1,139,260
ROTC Contract	53,620	131,319	184,939	5.00	924,693
OCS	43,880	127,293	171,173	5.72	979,107
PILOT:					
USNA	229,227	1,289,253	1,518,480	2.31	3,507,689
ROTC Scholarship	93,653	1,288,707	1,382,360	2.66	3,677,078
ROTC Contract	53,620	1,287,635	1,341,255	3.20	4,292,014
OCS	34,813	1,284,301	1,319,114	3.49	4,603,709
NFO:					
USNA	229,227	1,440,660	1,669,887	2.58	4,308,309
ROTC Scholarship	93,653	1,440,120	1,533,773	3.02	4,631,995
ROTC Contract	53,620	1,439,699	1,493,319	2.92	4,360,490
OCS	34,813	1,438,944	1,473,757	3.09	4,553,911

Table 4. Average Pre- and Post-commissioning Costs Required to Maintain Steady State Flow by Community and Source, in 2002 Dollars (from Bernard, 2002)

| | Discounted Costs | | | | |
Accession Source	Pre-Commissioning	Post-Commissioning	Total	Number of Accessions	Costs Per O-4
SURFACE:					
USNA	121,000	80,044	201,044	4.47	898,667
ROTC Scholarship	132,000	70,640	202,640	7.20	1,459,008
ROTC Contract	91,967	82,841	174,808	4.29	749,926
OCS	58,000	79,302	137,302	6.36	873,241
SUBMARINE:					
USNA	121,000	131,656	252,656	4.10	1,035,890
ROTC Scholarship	132,000	129,731	261,731	5.10	1,334,828
ROTC Contract	91,967	131,319	223,286	5.00	1,116,430
OCS	58,000	127,293	185,293	5.72	1,059,876
PILOT:					
USNA	121,000	1,289,253	1,410,253	2.31	3,257,684
ROTC Scholarship	132,000	1,288,707	1,420,707	2.66	3,779,081
ROTC Contract	91,967	1,287,635	1,379,602	3.20	4,414,726
OCS	58,000	1,284,301	1,342,301	3.49	4,684,630
NFO:					
USNA	121,000	1,440,660	1,561,660	2.58	4,029,083
ROTC Scholarship	132,000	1,440,120	1,572,120	3.02	4,747,802
ROTC Contract	91,967	1,439,699	1,531,666	2.92	4,472,465
OCS	58,000	1,438,944	1,496,944	3.09	4,625,557

Table 5.   Marginal Pre- and Post-commissioning Costs Required to Maintain
Steady State Flow by Community and Source, in 2002 Dollars
(from Bernard, 2002)

Bernard's results showed that USNA was the most cost-effective commissioning program to meet future accession needs. It also determined that NROTC-C accessions were more likely to stay and promote to O-4 than NROTC-S and OCS. However, due to size limitations, NROTC-C is not the best option available to the Navy for accession compared to NROTC-S and OCS. The thesis also showed that NROTC-S had significantly higher costs than other accession sources.

B.   COST-EFFECTIVENESS OF SERVICE ACADEMIES

Dr. William R. Bowman's 1995 paper, *Cost-Effectiveness of Service Academies: New Evidence from Navy Warfare Communities* researched the cost-effectiveness of the United States Naval Academy in a steady state environment. Bowman's study was the first to examine the full life cycle cost of accession sources for naval officers. Previous studies had reviewed the salient cost-effective measure of previous studies of pre-commissioning costs to the Navy regarding training and educating newly commissioned

officers (Bowman, 1995). Bowman combined methodology for determining a return on investment, estimated the independent impact the accession source held on officer performance, and used cost data from pre-commissioning training to post-commissioning education and training to determine full life cycle cost (Bowman, 1995). The information combined revealed the cost-effectiveness of the three major commissioning sources, USNA, NROTC, and OCS.

The study then examined empirical regression models of retention and promotion rates involving four URL communities, Surface Warfare, Submarine Warfare, Pilot, and Naval Flight Officer (NFO). The data basis for the models utilized Officer Data Card Information from the four URL communities from 1976–1981. The models observed exit flow rates of voluntary quits and involuntary separation to determine required accessions in order to maintain a steady state environment.

Bowman's cost-effectiveness study was important because the of the Navy's tendency to front-load human capital investments with the expectation to receive a return on investment with longer service time (1995). Bowman determined there was not a single accession source that was the most cost-effective across the warfare communities. The data showed that OCS accessions were most cost effective in the surface community, but NROTC accessions were most cost-effective in the NFO community. Even though the average undergraduate spending of an USNA graduate was nearly $200,000, the study showed it was cost-effective due to lower turnover rates than the other accession sources. That cost was significantly higher than the pre-commissioning costs of an OCS accession of $28,523; OCS accessions had a much higher attrition rate.

C.   OPTIMIZING OFFICER ACCESSION SOURCES

Ann Parcel's 2001 study, *Optimizing Officer Accession Sources*, examined two methods of optimizing officer accession sources. Her research studied the long term cost of a potential annual 100-officer accession increase from USNA compared to increasing annual NROTC and OCS accessions to arrive at a fixed number of officers at 20 years of commissioned service (YCS). Twenty years is the typical time in service that an officer has to retire from active military service with a standard pension.

First, Parcel (2001) compared the number of NROTC and OCS annual accessions required to make the same number of officers at YCS 20 given an additional 100 USNA accessions. Second, she looked at the number of NROTC and OCS accessions required to meet the same total endstrength at YCS 20 produced by 100 USNA annual accessions.

Her results showed in the long run that USNA was favorably compared to other accession sources, specifically OCS. She concluded there are potential savings using a steady state method by marginally increasing USNA accessions than by increasing OCS URL accessions. The findings determined that USNA produced the most senior force through 20 YCS with the fewest amount of officers, USNA had comparably more officers with technical backgrounds and that the marginal cost per additional accession was low given current infrastructure.

D. ANALYSIS OF NAVY NURSE CORPS ACCESSION SOURCES

The 2014 NPS thesis by Christopher Harvie, titled *An Analysis of Navy Nurse Corps Accession Sources*, built upon previous NPS theses analyzing costs and retention rates for the different Nurse Corps (NC) accessions. The thesis used logistical regression analysis to compare retention rates of Nurse Corps Officers (NCO) at six and 11 years of service. Further analysis determined the most expensive and least expensive accession source and compared that with retention rates.

The NC accession sources analyzed in Harvie's study were Direct Accession, NROTC, Nurse Candidate Program (NCP), Medical Enlisted Commissioning Program (MECP), and the Seaman to Admiral Program (STA-21).

The data used in Harvie's 2014 study was collected from the Bureau of Medicine Information Systems from all active duty nurses from FY 00–13. The data set was broken down into two cohorts, nurses entering the Navy between FY 00–02 and nurses entering between FY 04–07.

The six-year milestone was chosen because, in the NC, six years is the first time an individual can choose to stay or leave the service upon completion of initial obligation. The 11-year milestone was chosen because service members staying past the

10-year point were assumed to make the military a career and stay in until retirement (Harvie, 2014).

The 2014 study used a logistic regression model to analyze the data from the cohorts FY 00-02 and FY 04–07. The model analyzed the probability that the officer would retain in service (Harvie, 2014).

The model used for the cohort FY 00–02 was:

RETAIN= *f*(GFY01 GFY02 NROTC NCP MECP MALE LTJG LT PRIOR)

The basis of his model was a female Ensign without prior military service that entered the NC through Direct Accession in FY 00.

The RETAIN measured if the individual was retained for six or 11 years of service. The GFY variable represents the FY when an individual entered the NC. The NROTC, NCP, MECP, and Direct variables represent accession source into the NC. The MALE variable represents males that entered the NC. The ENS, LTJG, LT variables represent the rank an individual was given at time of commission. The PRIOR variable represents if an individual had four or more years of prior military service. All variables were given a value of "1" if they described the criteria and given a value of "0" if not.

The model used for the cohort FY 04-07 was:

RETAIN= *f*(GFY05 GFY06 GFY07 NROTC NCP MECP STA-21 MALE LTJG LT PRIOR)

The basis of his model was a female Ensign without prior military service that entered the NC through Direct Accession in FY04.

The RETAIN measured if the individual was retained for six years of service. The GFY variable represents the FY when an individual entered the NC. The NROTC, NCP, MECP, STA-21, and Direct variables represent accession source into the NC. The MALE variable represents males that entered the NC. The ENS, LTJG, LT variable represents the rank an individual was given at time of commission. The PRIOR variable represents if an individual had four or more years of prior military service. All variables were given

a value of "1" if they described the criteria and given a value of "0" if not. The six- and 11-year retention rate analysis by FY is shown in Table 6.

FY	6-Year Retention Rates (Percent)	11-Year Retention Rates (Percent)
2000	84.16	64.25
2001	69.47	48.85
2002	64.46	46.12
2003	57.48	
2004	63.73	
2005	66.3	
2006	72.73	
2007	68.77	
Average	68.39	53.07

Table 6.   FY Retention Rates (from Harvie, 2014)

The 2014 Harvie thesis found that the STA-21 program had the highest six-year retention rate at 91.23 percent and the NROTC program had the lowest six-year retention rate at 54.62 percent. The MECP program had the highest 11-year retention rate at 71.9 percent and the NCP program had the lowest 11-year retention rate at 52.88 percent (Harvie, 2014). The six-year model concluded that being a male, LT, and entering through the MECP program increased the probability of being retained. The 11-year model concluded that being a male, with prior service, and entering through the NCP program increased the probability of being retained (Harvie, 2014).

The thesis also determined that the most expensive accession source was the STA-21 program with a weighted average cost of $196,744 per individual and the least expensive accession source was Direct Accession with a weighted average cost of $25,000 per individual.

III.   DATA VARIABLES AND METHODOLOGY

Data for this thesis was collected using a data request to the Defense Manpower Data Center (DMDC). The data consists of military officer data information from officers who commissioned between year groups FY 1990–2000. The officers included were from the Navy. The data is a panel data set that tracks naval officers throughout their careers.

The data file consisted of 18 personal characteristics for each officer commissioned under 20 commissioning programs. The initial data file contained records of 199,560 officers from all branches of the military. The data file was reduced to focus on naval officers only and 51,271 naval officers were observed for data analysis. The data file was further reduced to 31,004 naval officers to focus on the three major naval officer accession sources, USNA, NROTC, and OCS. 20,599 officers commissioned from sources other than the three listed above were removed from consideration.

Variables were grouped into the following categories: Promotion, Demographics, Human Capital, and Control Variables. Table 7 lists the variables and their descriptions. The variable description explains how each dependent and explanatory variable were coded.

VARIABLE	DESCRIPTION
DEPENDENT VARIABLES	
Promotion	
MAKE_LCDR	=1 IF PROMOTED TO O-4; =0 IF OTHERWISE
MAKE_CDR	=1 IF PROMOTED TO O-5; =0 IF OTHERWISE
INDEPENDENT VARIABLES	
Demographics	
AGE	AGE AT COMMISSIONING (IN YEARS)
WHITE	= 1 IF RACE IS WHITE; = 0 IF OTHERWISE
BLACK	= 1 IF RACE IS BLACK; = 0 IF OTHERWISE
HISPANIC	= 1 IF RACE IS HISPANIC; = 0 IF OTHERWISE
OTHER	= 1 IF RACE IS OTHER; = 0 IF OTHERWISE
MALE	= 1 IF GENDER IS MALE; = 0 IF GENDER IS FEMALE
Human Capital	
GRAD_DEGREE	= 1 IF POSTGRADUATE DEGREE WAS EARNED; = 0 IF OTHERWISE
USNA	= 1 IF ACCESSION SOURCE WAS USNA; = 0 IF OTHERWISE
NROTC	= 1 IF ACCESSION SOURCE WAS NROTC; = 0 IF OTHERWISE
OCS	= 1 IF ACCESSION SOURCE WAS OCS; = 0 IF OTHERWISE
Accession Years	
YG1990	= 1 IF ACCESSED IN 1990; = 0 IF OTHERWISE
YG1991	= 1 IF ACCESSED IN 1991; = 0 IF OTHERWISE
YG1992	= 1 IF ACCESSED IN 1992; = 0 IF OTHERWISE
YG1993	= 1 IF ACCESSED IN 1993; = 0 IF OTHERWISE
YG1994	= 1 IF ACCESSED IN 1994; = 0 IF OTHERWISE
YG1995	= 1 IF ACCESSED IN 1995; = 0 IF OTHERWISE
YG1996	= 1 IF ACCESSED IN 1996; = 0 IF OTHERWISE
YG1997	= 1 IF ACCESSED IN 1997; = 0 IF OTHERWISE
YG1998	= 1 IF ACCESSED IN 1998; = 0 IF OTHERWISE
YG1999	= 1 IF ACCESSED IN 1999; = 0 IF OTHERWISE
YG2000	= 1 IF ACCESSED IN 2000; = 0 IF OTHERWISE

Table 7.   Variables Used and Their Descriptions

(1)   Promotion

The variable MAKE_LCDR was a binary variable to signify if an officer was promoted to lieutenant commander, O-4. MAKE_LCDR was given a value of 1 if the officer promoted to O-4 and 0 if they did not.

The variable MAKE_CDR was a binary variable to signify if an officer was promoted to commander, O-5. MAKE_CDR was given a value of 1 if the officer promoted to O-5 and 0 if they did not.

(2)   Demographics

The variable AGE represents the officer's age at the time of commissioning. Officers who are older when commissioned may be more mature than younger officers.

The variables WHITE, BLACK, HISPANIC, and OTHER are binary variables which represent an officer's race or ethnicity. The variable OTHER includes all races and ethnicities not included in WHITE, BLACK, or HISPANIC. These variables help determine if certain races and ethnicities promote at different rates. The variables were given a value of 1 if the met the criteria and a value of 0 if they did not meet the criteria.

The variable MALE is a binary variable used to determine the officer's gender. MALE=0 indicates the officer is female.

(3)   Human Capital

The variable GRAD_DEGREE is a binary variable which labeled level of education beyond bachelor's degrees. GRAD_DEGREE =1 if the officer held a master's degree or professional or doctorate degree.

The variables USNA, NROTC, and OCS are binary variables which represented the officer's accession source. These are the three major accession sources which produce naval officers. Each variable was given a value of 1 if the officer accessed from that source. It was used as a basis for comparing multivariate regression models in determining significance for promotion to the O-4 lieutenant commander and O-5 commander pay grades.

(4) Control Variables

The control variables were accounted for by the accession year. This accounted for the years of accession and to include across years of accession. Dummy variables were created to identify these accession years. Dummy variables were also created to account for occupation specialty within the dataset. Occupational specialties are available upon request.

IV. MULTIVARIATE DATA ANALYSIS

A. PROMOTION PROBABILITY SUMMARY STATISTICS

This section of the thesis examines and identifies promotion rates to the O-4 and O-5 promotion points based on differences in accession sources and other human demographics. Before developing multivariate regression models to help explain the effects that accession sources have on promotion, the data group statistics have been summarized. The standard deviation for the dummy variables have nominal meaning. Table 8 shows the summary data group statistics.

VARIABLE	OBSERVATIONS	MEAN
DEPENDENT VARIABLES		
MAKE LIEUTENANT COMMANDER	31004	45%
MAKE COMMANDER	31004	21%
INDEPENDENT VARIABLES		
COMMISSIONED BY USNA	31004	17%
COMMISSIONED BY NROTC	31004	23%
COMMISSIONED BY OCS	31004	17%
MALE	31004	83%
AGE	31004	26 years
WHITE	31004	79%
BLACK	31004	7%
HISPANIC	31004	6%
OTHER RACES	31004	6%
RECEIVED GRADUATE DEGREE	31004	7%

Table 8.   Summary Data Group Statistics

My analysis uses data on 31,004 naval officer observations. All three major accession sources were very similarly represented, with USNA representing 17 percent, NROTC representing 23 percent, and OCS representing 17 percent of the officer population on average. Eighty-three percent of the officers were male with an average age of 26 years. Seventy-nine percent of the officers were white, 7 percent were black, 6 percent were Hispanic, and 6 percent were other races. About 7 percent of officers had postgraduate degrees.

B.   PROMOTION RATES TO LIEUTENANT COMMANDER

This section of the thesis examines and identifies the differences of promotion rates from various accession sources of naval officers to the O-4 promotion point. It will then be used as a tool to help identify potential cost savings for commissioning Naval officers. It may be difficult to utilize a single statistic in determining accession source effectiveness in determining a propensity to stay in the Navy. Initial analysis of different accession sources have been grouped into three main categories: USNA, NROTC, and OCS. Previous studies have used different sources in determining cost-effectiveness. USNA, NROTC, and OCS were used by Bowman (1995) and Parcell (2001). Another study used USNA, NROTC- S, NROTC-C, OCS, and ECP (Bernard, 2002). ECP was merged into the STA-21Program and is no longer a stand-alone commissioning program.

All statistics are represented by percentages except for age. Our data set showed that on average, about 45 percent of officers included in the dataset would promote to the rank of lieutenant commander.

C.   PROMOTION RATES TO COMMANDER

This section of the thesis examines and identifies the differences of promotion rates from various accession sources of naval officers to the O-5 promotion point. It builds upon the previous section which examined promotion rates to the O-4 promotion point.

Similar to the previous section, the same accession sources were used to compare promotion rates to O-5. On average, of the officers who promoted to O-4, 21 percent would then promote to the rank of commander.

V. MULTIVARIATE REGRESSION ANALYSIS

Multivariate regression analysis examines the effects of multiple independent variables on the value of a dependent variable or outcome. All variables used have been coded nominally with a value of 0 or 1, as listed in Chapter III, with the exception of the age variable.

The four numbered columns shown in Tables 9 and 10 are four different regressions examined using the officer data described in previous chapters. I used the Linear Probability Model regression in this thesis. Column 1 was a regression that ignores year of commission and military occupation title while comparing the significance of promotion to O-4 and O-5. Column 2 was a regression that factored year of commission, but excluded occupation title while comparing the significance of promotion to O-4 and O-5. Column 3 was a regression that factored occupation title while excluding year of commission while comparing the significance of promotion to O-4 and O-5. Column 4 was a regression that factored year of commission and occupation title while comparing the significance of promotion to O-4 and O-5.

For each variable in every column, there are two numbers. The top number represents the coefficient of the regression analysis holding the control variables constant. The bottom number represents the standard errors, which shows how well the model fits the data. The asterisks on the data represent how significant the data is relating to the P values and the possibility the data hypothesis is supported. The * represents being statistically significant at the ten percent level, while ** represents being statistically significant at the five percent level, and *** represents being statistically significant at the one percent level.

A. PROMOTION TO LIEUTENANT COMMANDER

Initial multivariate analysis uses a basic model to estimate the effects of promotion to the O-4 promotion point by accession source compared to the Naval Academy. Table 9 shows the regression promotion model to lieutenant commander. The

following equations were used to conduct multivariate regressions on promotion possibility to lieutenant commander.

PROMOTION TO O-4 WITHOUT COMMISSIONING YEAR OR OCCUPATION VARIABLES

$ReachO4_{i,t+1} = \beta_1 NROTC_{i,t} + \beta_2 OCS_{i,t} + \beta_3 Male_{i,t} + \beta_4 Age_{i,t} + \beta_5 Black_{i,t} + \beta_6 Hispanic_{i,t} + \beta_7 Other\ Races_{i,t} + \beta_8 Grad\ Degree_{i,t} + \varepsilon_{i,t}$

PROMOTION TO O-4 WITH COMMISSIONING YEAR VARIABLES

$ReachO4_{i,t+1} = \beta_1 NROTC_{i,t} + \beta_2 OCS_{i,t} + \beta_3 Male_{i,t} + \beta_4 Age_{i,t} + \beta_5 Black_{i,t} + \beta_6 Hispanic_{i,t} + \beta_7 Other\ Races_{i,t} + \beta_8 Grad\ Degree_{i,t} + \mathbf{X'_{i,t}\lambda} + \varepsilon_{i,t}$

PROMOTION TO O-4 WITH OCCUPATION VARIABLES

$ReachO4_{i,t+1} = \beta_1 NROTC_{i,t} + \beta_2 OCS_{i,t} + \beta_3 Male_{i,t} + \beta_4 Age_{i,t} + \beta_5 Black_{i,t} + \beta_6 Hispanic_{i,t} + \beta_7 Other\ Races_{i,t} + \beta_8 Grad\ Degree_{i,t} + \mathbf{Z'_{i,t}\delta} + \varepsilon_{i,t}$

PROMOTION TO O-4 WITH COMMISSIONING YEAR AND OCCUPATION VARIABLES

$ReachO4_{i,t+1} = \beta_1 NROTC_{i,t} + \beta_2 OCS_{i,t} + \beta_3 Male_{i,t} + \beta_4 Age_{i,t} + \beta_5 Black_{i,t} + \beta_6 Hispanic_{i,t} + \beta_7 Other\ Races_{i,t} + \beta_8 Grad\ Degree_{i,t} + \mathbf{X'_{i,t}\lambda} + \mathbf{Z'_{i,t}\delta} + \varepsilon_{i,t}$

Where $ReachO4_{i,t+1}$ is a dummy variable equal to 1 if sailor i reached the rank of O-4 in time period $t + 1$ and 0 otherwise. Of note, time period t represents the year the individual sailor entered service and $t + 1$ signifies any time after the initial entry year. The variable *NROTC* is a dummy variable equal to 1 if sailor i received their commission through the Naval ROTC program, *OCS* is a dummy variable equal to 1 if sailor i received their commission through the Officer Candidate program, *Male* is a dummy variable equal to 1 for being a male, *Age* is a continuous variable for the sailor's age, *Black*, *Hispanic*, and *Other Races* are dummy variables indicating the race of sailor i; $\mathbf{X}$ is a vector of dummy variables for year of commission t for sailor i, and $\mathbf{Z}$ is a vector of dummy variables the type of occupation sailor i has in the year of their commission. The coefficients β_1 and β_2 are the parameters of interest in predicting which commission source is more effective at promoting to lieutenant commander.

O-4 PROMOTION REGRESSION ANALYSIS				
VARIABLE	PROMOTION TO O-4 WITHOUT TIME OR JOB VARIABLES	PROMOTION TO O-4 WITH TIME VARIABLES	PROMOTION TO O-4 WITH JOB VARIABLES	PROMOTION TO O-4 WITH TIME AND JOB VARIABLES
COMMISSIONED BY NROTC	-0.0572***	-.0547***	-.0556***	-.0511***
	0.0057	0.0056	.0060	.0060
COMMISSIONED BY OCS	.0306***	.0245***	.0240***	.0195***
	.0059	.0060	.0066	.0066
MALE	.0799***	.0804***	.0830***	.0846***
	.0058	.0058	.0064	.0064
AGE	.0058***	.0056***	.0085***	.0083***
	.0003	.0003	.0004	.0004
BLACK	-.0247***	-.0298***	-.0023	-.0070
	.0083	.0083	.0082	.0082
HISPANIC	.0135	-.0030	.0162*	-.0001
	.0093	.0094	.0093	0.0093
OTHER RACES	-.0178**	-.0253***	-.0167*	-.0244***
	.0094	.0094	.0093	.0092
RECEIVED POSTGRADUATE DEGREE	.1277***	.1178***	.0988***	.0872***
	.0085	.0086	.0086	.0086
COMMISSIONING YEAR DUMMY VAR	NO	YES	NO	YES
JOB DUMMY VAR	NO	NO	YES	YES
OBSERVATIONS	31004	31004	31004	31004
R2	0.0222	0.0315	0.0541	0.0634

Asterisks denote levels of significance.

* = significant at the 10% level, ** = significant at the 5% level

*** = significant at the 1% level

Table 9.   Regression Analysis on Promotion to O-4

1. Without Factoring Time and Job Variables

This regression promotion model was produced for promotion to lieutenant commander without factoring year of commissioning or occupation title. Control variables were used to determine the effect of the independent variables on the dependent variables.

The accession sources, NROTC and OCS were compared to USNA in determining the probability of promotion to O-4. The results of Table 9 Column 1 show that officers accessing from OCS on average had a 3.1 percent increase in probability of promotion to O-4 in comparison to USNA officer accessions. NROTC officer accessions on average had a 5.7 percent decrease in probability of promotion in comparison to USNA accessions. These sources were statistically significant at the 1% level and there were differences in promotion between them. Males on average had an 8.0 percent increase in probability of promoting to O-4 over females. Black officers on average had a 2.5 percent decrease in probability of promotion. Hispanic officers show an increase in the probability of promotion in comparison to white officers; however this outcome is not statistically different than zero. Officers of other races on average had a 1.8 percent decrease in probability of promotion in comparison to white officers. The black officer variable was statistically significant at the 1% level. The officers of other races variable was statistically significant at the 5% level. Officers with a graduate degree or higher on average had a 12.8 percent increase in probability of promotion O-4 in comparison to officers with only a baccalaureate degree. Graduate degrees were also statistically significant at the 1% level and showed a strong correlation of promotion to O-4.

2. Factoring Time Variables

This regression promotion model was produced for promotion to lieutenant commander factoring in year of commissioning. Control variables were used to determine the effect of the independent variables on the dependent variables.

The results of Table 9 Column 2 showed that officers accessing from OCS on average had a 2.5 percent increase in probability of promotion to O-4 in comparison to USNA officer accessions. NROTC officer accessions on average had a 5.5 percent

decrease in probability of promotion in comparison to USNA accessions. These sources were statistically significant at the 1% level and there were differences in promotion between them. Males on average had an 8.0 percent increase in probability of promotion to O-4 over females. The male variable was statistically significant at the 1% level. Black officers on average had a 3.0 percent decrease in probability of promotion. Hispanic officers show a decrease in the probability of promotion in comparison to white officers; however this outcome is not statistically different than zero. Officers of other races on average had a 2.5 percent decrease in probability of promotion to O-4 in comparison to white officers. The black officer and officers of other races variables were statistically significant at the 1% level. Officers with a graduate degree or higher on average had an 11.8 percent increase in probability of promotion to O-4 in comparison to officers with only a baccalaureate degree. Graduate degrees were also statistically significant at the 1% level and showed a strong correlation of promotion to O-4.

3.   Factoring Job Variables

This regression promotion model was produced for promotion to lieutenant commander factoring in occupation title. Control variables were used to determine the effect of the independent variables on the dependent variables.

The results of Table 9 Column 3 showed that OCS officer accessions on average had a 2.4 percent increase in probability of promotion to O-4 in comparison to USNA officer accessions. NROTC officer accessions on average had a 5.6 percent increase in probability of promotion in comparison to USNA accessions. These sources were statistically significant at the 1% level and there were differences in promotion between them. Males on average had an 8.3 percent increase in probability of promotion to O-4 over females. The male variable was statistically significant at the 1% level. Black officers on average show a decrease in the probability of promotion in comparison to white officers; however this outcome is not statistically different than zero. Hispanic officers on average had a 1.6 percent increase in probability of promotion to O-4 in comparison to white officers. Officers of other races on average had a 1.7 percent decrease in probability of promotion in comparison to white officers. The Hispanic and

other races variables were statistically significant at the 10% level. Officers with a graduate degree or higher on average had a 9.9 percent increase in probability of promotion to O-4 in comparison to officers with only a baccalaureate degree. Graduate degrees were also statistically significant at the 1% level and showed a strong correlation of promotion to O-4.

4.   Factoring Time and Job Variables

This regression promotion model was produced for promotion to lieutenant commander factoring in year of commissioning and occupation title. Control variables were used to determine the effect of the independent variables on the dependent variables. This regression is the primary regression of interest, since it includes all of the control variables.

The results of Table 9 Column 4 showed that OCS officer accessions on average had a 1.9 percent increase in probability of promotion to O-4 in comparison to USNA officer accessions. NROTC officer accessions on average had a 5.1 percent decrease in probability of promotion in comparison to USNA accessions. These sources were statistically significant at the 1% level and there were differences in promotion between them. Males on average had an 8.5 percent increase in probability of promotion O-4 over females. The male variable was statistically significant at the 1% level. Black officers on and Hispanic officers show a decrease in the probability of promotion to O-4 in comparison to white officers, however this outcome is not statistically different than zero. Officers of other races on average had a 2.4 percent decrease in probability of promotion in comparison to white officers. The other races variable was statistically significant at the 1% level. Officers with a graduate degree or higher on average had an 8.7 percent increase in probability of promotion to O-4 in comparison to officers with only a baccalaureate degree. Graduate degrees were also statistically significant at the 1% level and showed a strong correlation of promotion to O-4.

5.   Summary

Analysis of the promotion results to O-4 showed that OCS officer accessions on average had a higher probability of promotion in comparison to USNA officer

accessions. USNA accessions on average were more likely to promote to O-4 in comparison to NROTC accessions. The analysis also showed when factoring time and job variables, the differences in probability of promotion by accession source decreased when compared to the regression without time or job variables factored. Officers with at least a graduate degree on average were significantly more likely to promote in comparison to those without. Male officers on average were also significantly more likely to promote in comparison to female officers. Regression data showed the race variables on average were inconclusive across all regressions on probability of promotion to O-4.

B. PROMOTION TO COMMANDER

Initial multivariate analysis uses a basic model to estimate the effects of promotion to the O-5 promotion point by accession source compared to USNA. Table 10 shows the regression promotion model to commander. The following equations were used to conduct multivariate regressions on promotion probability to commander.

PROMOTION TO O-5 WITHOUT COMMISSIONING YEAR OR OCCUPATION VARIABLES
$ReachO5_{i,t+1} = \beta_1 NROTC_{i,t} + \beta_2 OCS_{i,t} + \beta_3 Male_{i,t} + \beta_4 Age_{i,t} + \beta_5 Black_{i,t} + \beta_6 Hispanic_{i,t} + \beta_7 Other\ Races_{i,t} + \beta_8 Grad\ Degree_{i,t} + \varepsilon_{i,t}$

PROMOTION TO O-5 WITH COMMISSIONING YEAR VARIABLES
$ReachO5_{i,t+1} = \beta_1 NROTC_{i,t} + \beta_2 OCS_{i,t} + \beta_3 Male_{i,t} + \beta_4 Age_{i,t} + \beta_5 Black_{i,t} + \beta_6 Hispanic_{i,t} + \beta_7 Other\ Races_{i,t} + \beta_8 Grad\ Degree_{i,t} + \mathbf{X'_{i,t}}\boldsymbol{\lambda} + \varepsilon_{i,t}$

PROMOTION TO O-5 WITH OCCUPATION VARIABLES
$ReachO5_{i,t+1} = \beta_1 NROTC_{i,t} + \beta_2 OCS_{i,t} + \beta_3 Male_{i,t} + \beta_4 Age_{i,t} + \beta_5 Black_{i,t} + \beta_6 Hispanic_{i,t} + \beta_7 Other\ Races_{i,t} + \beta_8 Grad\ Degree_{i,t} + \mathbf{Z'_{i,t}}\boldsymbol{\delta} + \varepsilon_{i,t}$

PROMOTION TO O-5 WITH COMMISSIONING YEAR AND OCCUPATION VARIABLES
$ReachO5_{i,t+1} = \beta_1 NROTC_{i,t} + \beta_2 OCS_{i,t} + \beta_3 Male_{i,t} + \beta_4 Age_{i,t} + \beta_5 Black_{i,t} + \beta_6 Hispanic_{i,t} + \beta_7 Other\ Races_{i,t} + \beta_8 Grad\ Degree_{i,t} + \mathbf{X'_{i,t}}\boldsymbol{\lambda} + \mathbf{Z'_{i,t}}\boldsymbol{\delta} + \varepsilon_{i,t}$

Where $ReachO5_{i,t+1}$ is a dummy variable equal to 1 if sailor i reached the rank of O-5 in time period $t + 1$ and 0 otherwise. Of note, time period t represents the year the individual

sailor entered service and $t + 1$ signifies any time after the initial entry year. The variable *NROTC* is a dummy variable equal to 1 if sailor i received their commission through the Naval ROTC program, *OCS* is a dummy variable equal to 1 if sailor i received their commission through the Officer Candidate program, *Male* is a dummy variable equal to 1 for being a male, *Age* is a continuous variable for the sailor's age, *Black*, *Hispanic*, and *Other Races* are dummy variables indicating the race of sailor i; **X** is a vector of dummy variables for year of commission t for sailor i, and **Z** is a vector of dummy variables the type of occupation sailor i has in the year of their commission. The coefficients β_1 and β_2 are the parameters of interest in predicting which commission source is more effective at promoting to commander.

	O-5 PROMOTION REGRESSION ANALYSIS			
VARIABLE	PROMOTION TO O-5 WITHOUT TIME OR JOB VARIABLES	PROMOTION TO O-5 WITH TIME VARIABLES	PROMOTION TO O-5 WITH JOB VARIABLES	PROMOTION TO O-5 WITH TIME AND JOB VARIABLES
COMMISSIONED BY NROTC	.0058	.0056	-.0265***	-.0225***
	(.0047)	(.0046)	(.0050)	(.0050)
COMMISSIONED BY OCS	-0.0271***	-.0174***	-.0763***	-.0604***
	(.0049)	(.0049)	(.0055)	(.0054)
MALE	.0610***	.0588***	.0492***	.0499***
	(.0048)	(.0048)	(.0053)	(.0053)
AGE	.0008**	.0010***	.0050***	.0051***
	(.0003)	(.0003)	(.0003)	(.0003)
BLACK	-.0371***	-.0362***	-.0193***	-.0204***
	(.0069)	(.0068)	(.0069)	(.0068)
HISPANIC	-.0301***	-.0142*	-.0220***	-.0155**
	(.0078)	(.0078)	(.0077)	(.0077)
OTHER RACES	-.0199**	-.0135*	-.0206***	-.0164**
	(.0078)	(.0077)	(.0077)	(.0077)
RECEIVED POSTGRADUATE DEGREE	.0488***	.0652***	.0309***	.0465***
	(.0071)	(.0071)	(.0072)	(.0072)
TIME DUMMY VAR	NO	YES	NO	YES
JOB DUMMY VAR	NO	NO	YES	YES
OBSERVATIONS	51271	51271	51271	51271
R2	0.0059	0.0315	0.0343	0.054
Asterisks denote levels of significance.				
* = significant at the 10% level, ** = significant at the 5% level				
*** = significant at the 1% level				

Table 10.   Regression Analysis for Promotion to O-5

1.   Without Factoring Time and Job Variables

This regression promotion model was produced for promotion to commander without factoring year of commissioning and occupation title. Control variables were used to determine the effect of the independent variables on the dependent variables.

The results of Table 10 Column 1 showed that OCS officer accessions on average had a 2.7 percent decrease in probability of promotion to promote O-5 in comparison to USNA accessions. NROTC officer accessions on average had a 0.6 percent increase in probability of promotion to O-5 in comparison to USNA accessions. The NROTC coefficient was insignificant and there were no differences in promotion possibilities. The OCS variable was statistically significant at the 1% level and there were differences in promotion probability. Males on average had a 6.1 percent increase in probability of promotion to O-5 over females. The male variable was statistically significant at the 1% level. Black officers on average had a 3.7 percent decrease in probability of promotion and Hispanic officers on average had a 3.0 percent decrease in probability in promotion in comparison to white officers, respectively. Officers of other races on average had a 2.0 percent decrease in probability of promotion to O-5 in comparison to white officers. The black officer and the Hispanic officer variables were statistically significant at the 1% level. The officers of other races variable were statistically significant at the 5% level. Officers with a graduate degree or higher on average had a 4.9 percent increase in probability of promotion to O-5 in comparison to officers with only a baccalaureate degree. Graduate degrees were also statistically significant at the 1% level and showed a strong correlation of promotion to O-5.

2.   Factoring Time Variables

This regression promotion model was produced for promotion to commander factoring in year of commissioning. Control variables were used to determine the effect of the independent variables on the dependent variables.

The results of Table 10 Column 2 showed that OCS officer accessions on average had a 1.7 percent decrease in probability of promotion to O-5 in comparison to USNA accessions. NROTC officer accessions on average had a 0.6 percent increase in

probability of promotion in comparison to USNA accessions. The OCS variable was statistically significant at the 1% level in relation to promotion. Males on average had a 5.9 percent increase in probability of promotion to O-5 over females. The male variable was statistically significant at the 1% level. Black officers on average had a 3.6 percent decrease in probability of promotion and Hispanic officers on average had a 1.4 percent decrease in probability of promotion to O-5 in comparison to white officers, respectively. Officers of other races on average had a 1.4 percent decrease in probability of promotion in comparison to white officers. The black officer variable was statistically significant at the 1% level. The Hispanic officer variable and the officers of other races variable were statistically significant at the 10% level. Officers with a graduate degree or higher on average had a 6.5 percent increase in probability of promotion to O-5 in comparison to officers with only a baccalaureate degree. Graduate degrees were also and the officers of other races variable and showed a strong correlation of promotion to O-5.

3. Factoring Job Variables

This regression promotion model was produced for promotion to commander factoring in occupation title. Control variables were used to determine the effect of the independent variables on the dependent variables.

The results of Table 10 Column 3 showed that OCS officer accessions on average had a 7.6 percent decrease in probability of promotion to O-5 in comparison to USNA accessions. NROTC officer accessions on average had a 2.7 percent increase in probability of promotion in comparison to USNA accessions. These sources were statistically significant at the 1% level and there were differences in promotion between them. Males on average had a 4.9 percent increase in probability of promotion to O-5 over females. The male variable was statistically significant at the 1% level. Black officers on average had a 1.9 percent decrease in probability of promotion and Hispanic officers on average had a 2.2 percent decrease in probability of promotion in comparison to white officers, respectively. Officers of other races on average had a 2.1 percent decrease in probability of promotion in comparison to white officers. The black officer variable, the Hispanic officer variable, and the officers of other races variable were

statistically significant at the 1% level. Officers with a graduate degree or higher on average had a 3.1 percent increase in probability of promotion to O-5 in comparison to officers with only a baccalaureate degree. Graduate degrees were also statistically significant at the 1% level and showed a strong correlation of promotion to O-5.

4.   Factoring Time and Job Variables

This regression promotion model was produced for promotion to commander factoring in year of commissioning and occupation title. Control variables were used to determine the effect of the independent variables on the dependent variables. This regression is the primary regression of interest, since it includes all of the control variables.

The results of Table 10 Column 4 showed that OCS officer accessions on average had a 6.0 percent decrease in probability of promotion to O-5 in comparison to USNA accessions. NROTC officer accessions on average had a 2.3 percent decrease in probability of promotion to O-5 in comparison to USNA accessions. These sources were statistically significant at the 1% level and there were differences in promotion between them. Males on average had a 5.0 percent increase in probability of promotion to O-5 over females. The male variable was statistically significant at the 1% level. Black officers on average had a 2.0 percent decrease in probability of promotion and Hispanic officers on average had a 1.6 percent decrease in probability of promotion in comparison to white officers, respectively. Officers of other races on average had a 1.6 percent decrease in probability of promotion in comparison to white officers. The black officer variable and Hispanic officer variable were statistically significant at the 1% level. The officers of other races variables were statistically significant at the 5% level. Officers with a graduate degree or higher on average had a 4.7 percent increase in probability of promotion to O-5 in comparison to officers with only a baccalaureate degree. Graduate degrees were also statistically significant at the 1% level and showed a strong correlation of promotion to O-5.

5.   Summary

Analysis of the promotion results to O-5 show that USNA officer accessions on average had a higher probability of promotion in comparison to OCS officer accessions. USNA accessions on average were more likely to promote in comparison to NROTC accessions. The analysis also showed when factoring time and job variables, the differences in probability of promotion by accession source decreased when compared to the regression without time or job variables factored. Officers with at least a graduate degree on average were more likely to promote in comparison to those without. Male officers on average were also more likely to promote in comparison to female officers. White officers on average also were slightly more likely to promote in comparison to Black officers, Hispanic officers, and officers of other races. Race was a factor in promotion from O-4 to O-5 but did not have an effect from O-3 to O-4.

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VI.   COST-EFFECTIVE ANALYSIS

Bowman (1995) determined that in maintaining a naval force at a given endstrength, it was imperative to understand a steady state model for the flow of naval officers. He also made the distinction to determine the technical and economic efficiency. This makes the assumption that the United States Naval Academy could be technically proficient at producing naval officers, but if they do so at a high enough initial pre-commissioning training cost, it would not be economically effective to produce one more naval officer from the Naval Academy as compared to NROTC or OCS.

Results from the analysis of promotion rates to the O-4 and O-5 promotion level described in Chapter IV and the multivariate analysis in Chapter V indicate that USNA is the most technically efficient accession source in promoting officers to the O-4 and O-5 promotion points. Bowman (1995) determined a methodology in analyzing costs using a steady state flow model. This thesis utilizes Bowman's model of steady state flow to determine cost effectiveness of accession sources.

Average and marginal costs were used to determine cost-effectiveness of the various commissioning sources.

A.   ACCESSION SOURCES USING MARGINAL COSTS

Parcell determined marginal pre-commissioning costs of the three major commissioning sources, USNA, NROTC, and OCS in her 2008 paper, *An Evaluation of URL Officer Accession Sources.* The marginal cost is the change in total costs when increasing the amount of commissioned officers by one officer. Parcell determined the marginal pre-commissioning costs in 2008 dollars. Marginal costs were inflated at a consumer price index (CPI) rate of 9.1 percent to convert dollar figures to 2014 dollars. Marginal pre-commissioning costs and their conversions to 2014 dollars are shown in Table 11.

Accession Source	2008 Dollars	2015 Dollars
USNA	$215,300	$236,900
NROTC	$135,000	$148,500
OCS	$21,600	$23,800

Table 11.   Marginal Pre-commissioning Costs by Accession Source

Parcell's study (2008) determined marginal costs associated with increasing the size of the USNA Brigade of Midshipman. Using continuation rates, the study determined the total endstrength that an additional 70 officer accessions would bring. This endstrength number was compared to similar endstrength numbers of 70 more officer accessions from NROTC and OCS. In reviewing the marginal costs for each of these sources, it is imperative to take into account the possibility of increasing officer accession size and the potential cost benefit. The paper examined marginal costs for each source and compared those costs of NROTC and OCS to USNA (Parcell, 2008). USNA and NROTC have much higher pre-commissioning costs in comparison to OCS due to the lengthy training timelines. USNA and NROTC pre-commissioning training timelines is 4 four years, while the OCS pre-commissioning training timeline is 12 weeks.

B.   ACCESSION SOURCES USING AVERAGE COSTS

Parcell (2008) determined the weighted average costs across USNA, NROTC, and OCS. These costs were determined assuming a constant endstrength after 20 YCS. These costs were also made assuming that accession sources do not produce an equal number of officer accessions. The paper examined pre-commissioning costs and used an estimate for post-commissioning training costs. Estimates were used due to the difficulty in determining actual training costs across multiple communities. USNA costs were used as a baseline and compared to NROTC and OCS. Table 12 shows the weighted cost analysis pre-commissioning and post-commissioning costs between USNA, NROTC, and OCS. Comparing the weighted costs converted to 2014 dollars to account for inflation shows the dollar amounts in millions of dollars spent.

WEIGHTED AVERAGE COSTS WITH CONSTANT ENDSTRENGTH TO 20 YCS		
	No Postcommissioning training costs ($ Millions)	Notional Postocommissioning training costs ($ Millions)
USNA Baseline	91.3	116.6
NROTC difference from USNA	-2.2 to -0.3	-0.2 to +1.7
OCS Difference from USNA	-3.7 to -2.1	-0.7 to +0.8

Table 12.   Weighted Average Costs from Parcell, 2008 Converted to 2014 dollars

These costs account for average costs across all communities. Only factoring in pre-commissioning costs, on average NROTC training costs almost two million dollars less in comparison to USNA and OCS costs approximately two to three million dollars less in comparison to USNA (Parcell, 2008).

C. COMPARISON

The difficulty in determining cost-effectiveness between the officer accession sources is there is lack of reporting guidance to compare the cost-effectiveness of an USNA officer accession to alternate officer accession sources. Also, there is not a universally accepted method to calculate the returns or benefits of different commissioning sources (Tench Francis, 2004). On average, USNA accepts 1000 naval officers annually (Parcell, 2008). A 2013 Government Accountability Office (GAO, 2014) study showed NROTC on average commissions 1,200 naval officers annually. These two accession sources are the major sources of naval officer accessions. OCS is used to provide flexibility for officer accessions to fulfill naval officer requirements to meet mission objectives.

Another difficulty in determining cost-effectiveness between officer accession sources is the accession sources were not designed to access an equal number of officers each year. Without increasing the size of facilities at USNA, officer accessions will soon be maximized. NROTC officer accessions are determined by programs already established. USNA and NROTC have a symbiotic relationship where changes in officer accessions in one source will cause an equal change in officer accessions in the other source. OCS officer accessions are used as a valve to fulfill officer accession gaps in the navy.

Regression analysis from Chapter V showed that when variables for commissioning year and occupation were factored, OCS officer accessions on average had a two percent increase in probability of promotion to O-4 in comparison to USNA officer accessions and NROTC officer accessions on average had a five percent decrease in probability of promotion to O-4 in comparison to USNA officer accessions. These statistics were statistically significant at the one percent level.

Regression analysis also showed when variables for commissioning year and occupation were factored; USNA officer accessions on average had a two percent increase in probability of promotion to O-5 in comparison to NROTC officer accessions and had a six percent increase in probability of promotion to O-5 in comparison to OCS officer accessions. These statistics were statistically significant at the one percent level.

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VII.   SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

A.   SUMMARY

My results of the regression models for promotion to the O-4 paygrade indicate that accession source was significant in the probability of promotion. OCS officer accessions had an increased probability of promotion over USNA and NROTC officer accessions. Comparing the regressions which factored time and job variables and the regression which ignored the time and job variables, the statistical results were significant. Age and race of the officer accessions were statistically significant. The ages of officer accessions were fairly similar due to age restriction policy for commissioned officers. Officers with graduate-level education had an increased probability of promotion. The statistical trend showed that in time as more officers earn graduate degrees, the value of the degree may diminish.

My results of the regression models for promotion to the O-5 paygrade indicate that accession source was significant in the probability of promotion. USNA officer accessions had an increased probability of promotion over OCS and NROTC officer accessions. Comparing the regressions which factored time and job variables and the regression which ignored the time and job variables, the statistical results were significant. Similar to the O-4 promotion analysis, the O-5 promotion analysis showed that age and race of the officer accessions were statistically significant. The ages of officer accessions were fairly similar due to age restriction policy for commissioned officers. The statistics also showed that an officer's race did not increase or decrease the probability of promotion. Officers with graduate level education had an increased probability of promotion. The statistical trend showed that in time as more officers earn graduate degrees, the value of the degree may diminish.

Officer accessions from USNA on average may have an increased probability of promotion at the O-5 promotion point due to the selective entrance process and the desire to be a career naval officer.

B. CONCLUSIONS

My cost-effective analysis of officer accession sources provide decision makers with palpable information to make informed choices for future force size and structure. These results are important because the statistical data showed how alternate accession sources can shape the naval forces.

The cost analyses developed in Chapter VI do not support the conclusions of previous studies (Bernard 2002; Parcell 2008) that USNA is the most cost-effective for officer accessions. USNA had the higher probability of promotion to O-5 but NROTC was more cost-effective. Given the symbiotic relationship of USNA and NROTC, these results do not support major changes being made to either accession source in number of annual officer accessions. OCS had the higher probability of promotion to O-4 and it was the most cost-effective, especially with the 12-week pre-commissioning training timeline compared to four year for USNA and NROTC. OCS accessions had a decreased probability of promotion compared to USNA and NROTC for promotion to O-5.

C. RECOMMENDATIONS

OCS is the most cost-effective accession source on the margin, and from a fiscal perspective all naval officer accessions should come from OCS. However, OCS is not designed for that purpose. My recommendation that resulted from this thesis is USNA and NROTC should continue to be primary sources of naval officer accessions. There are non-fiscal quantifiable characteristics that officer accessions gain from USNA and NROTC. Given the fixed costs for USNA and NROTC, the average amount of officer accessions should remain largely the same and OCS should continue to be used as a valve to fulfill naval officer accession needs. There is limited excess capacity at the Naval Academy for future accessions.

Graduate degrees may have less relevance in future promotion boards as more naval officers complete postgraduate education. This may result in changes to the amount of officers who remain in naval service past initial obligations to earn a postgraduate degree.

Future cost-effective analyses should focus on alternate accession sources promotion to O-6 and the flag officer ranks. Results should compare promotion possibilities and the number of officers considered who stay to the promotion board from alternate accession sources. Future studies should also repeat the cost-effective analysis of probability of promotion to the O-4 and O-5 promotion points utilizing different commissioning years. Data sets should also be compared from periods of peacetime and periods of conflict.

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